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(54) **PRISMATIC SECONDARY BATTERY**

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H01M 2/02	(2006.01)
H01M 2/04	(2006.01)
H01M 2/12	(2006.01)

(52) **U.S. Cl.**

CPC ***H01M 2/0217*** (2013.01); ***H01M 2/0237*** (2013.01); ***H01M 2/0426*** (2013.01); ***H01M 2/0439*** (2013.01); ***H01M 2/1223*** (2013.01); ***H01M 2/361*** (2013.01); ***H01M 2/362*** (2013.01)

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USPC 429/53, 57, 72, 82, 83, 163

See application file for complete search history.

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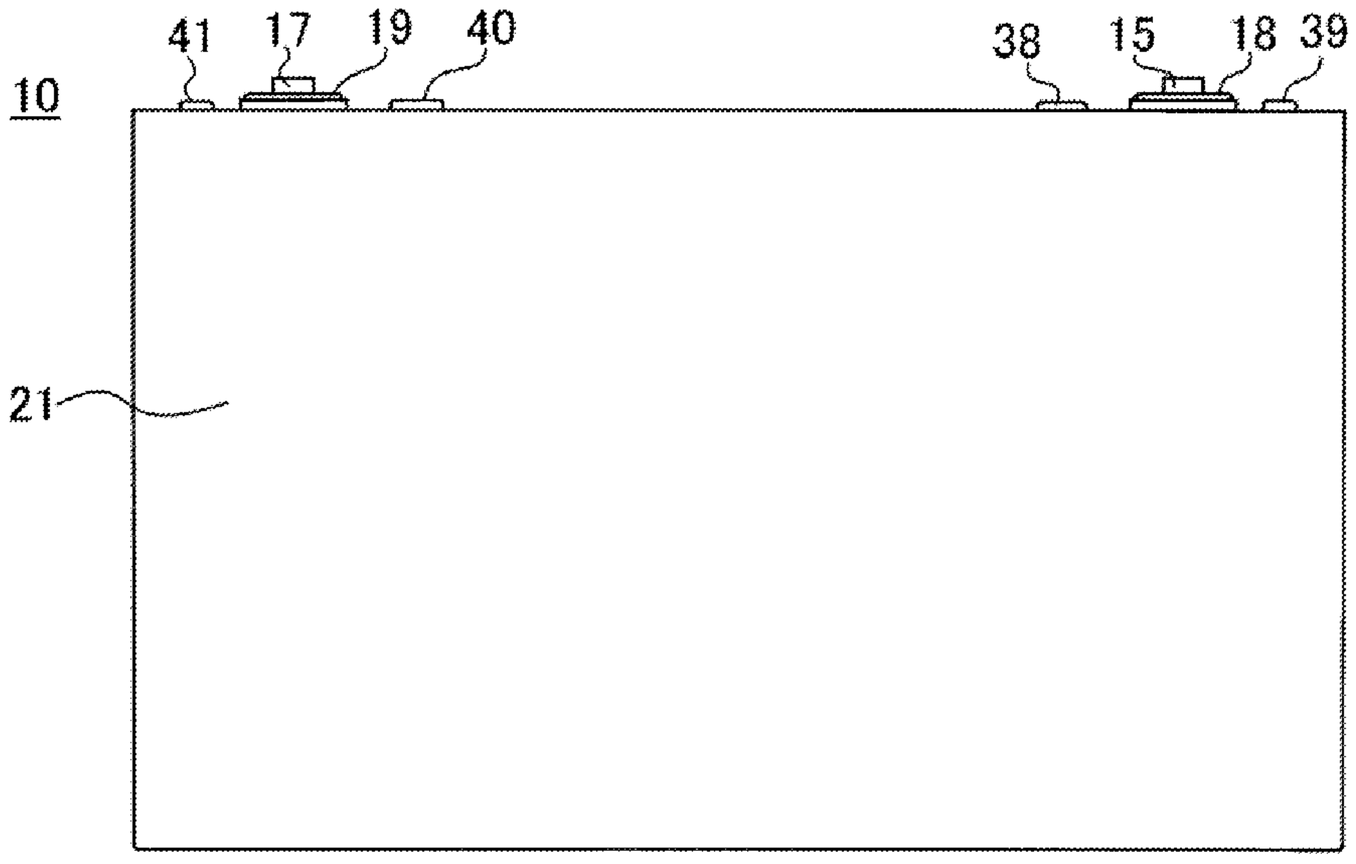
(57) **ABSTRACT**

A prismatic secondary battery includes a prismatic hollow outer body having a mouth and a bottom and storing an electrode assembly, a positive electrode collector, a negative electrode collector, and an electrolyte, a sealing plate sealing up the mouth of the prismatic hollow outer body, and a positive electrode terminal and a negative electrode terminal attached to the sealing plate; the sealing plate includes a gas release valve at the center between the positive electrode terminal and the negative electrode terminal and includes an electrolyte pour hole on one side of the gas release valve and, on the other side on the front face, a concaved flat face with a height lower than that of the peripheral portion; and the concaved flat face is formed with an identification code.

17 Claims, 3 Drawing Sheets



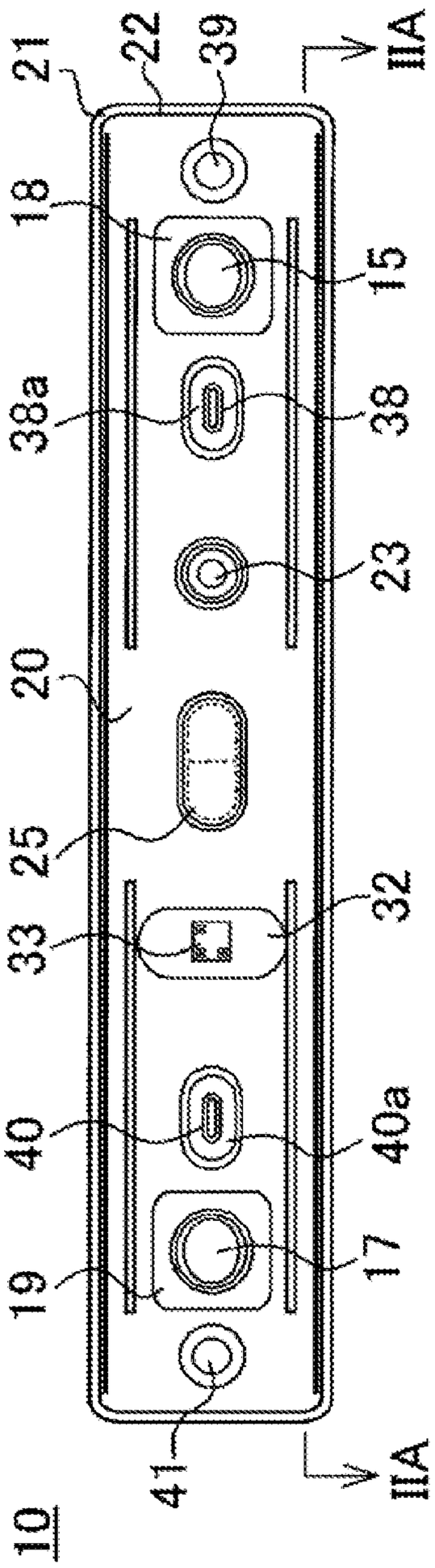

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Fig. 1B

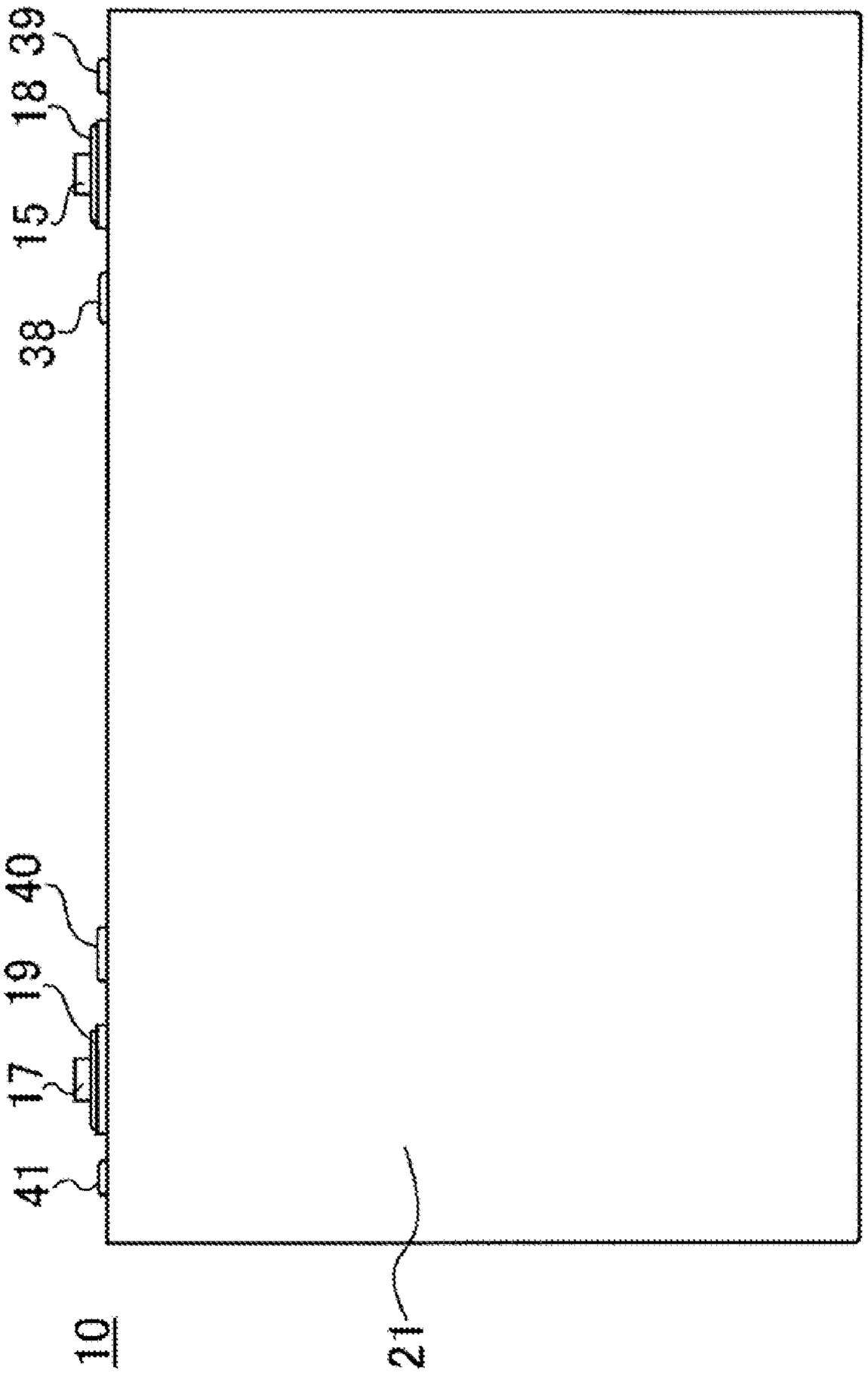
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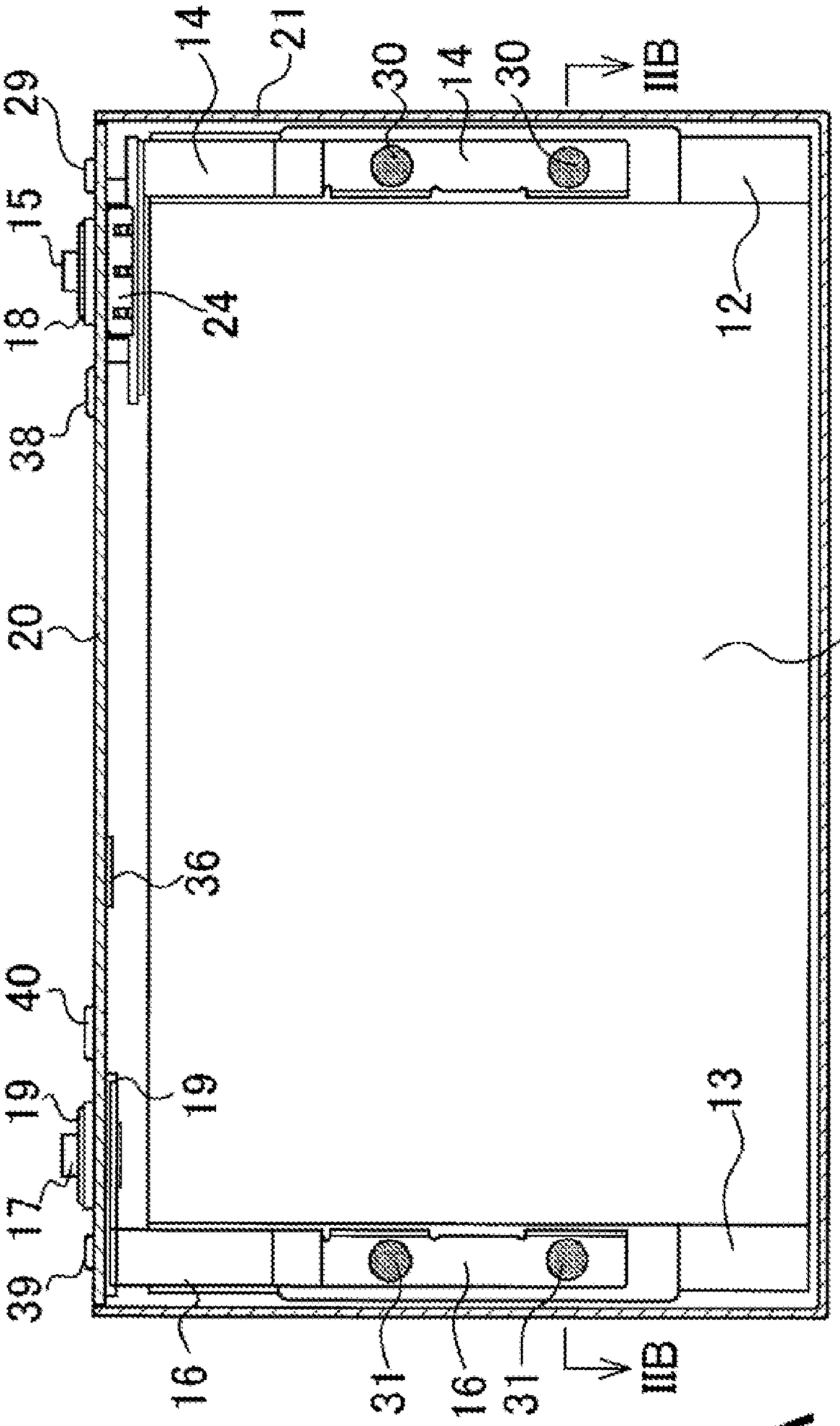
Fig. 1A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IIB
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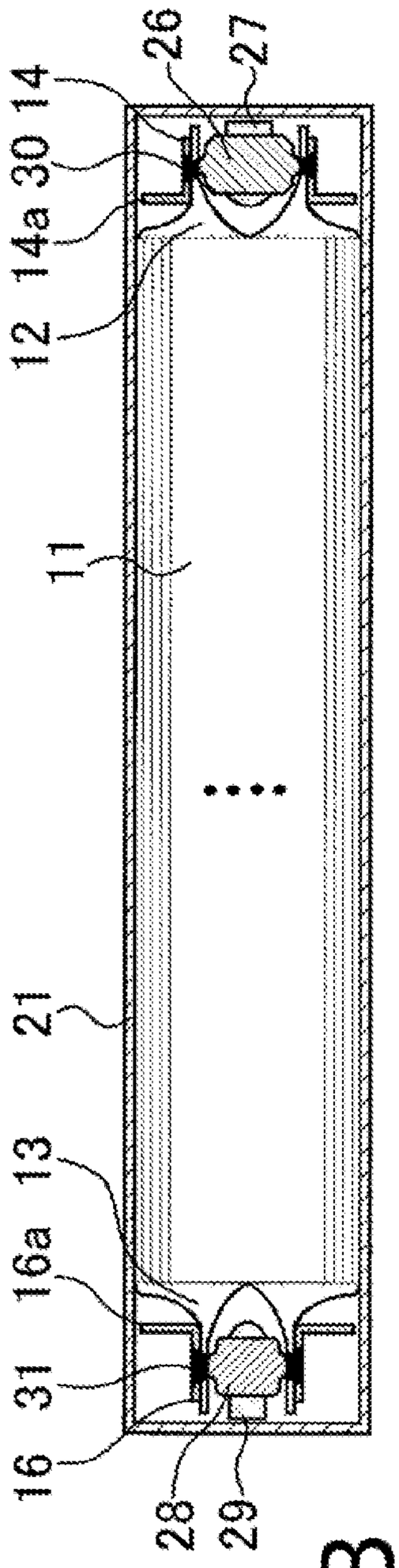
IIB

Fig.2A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13a
16a
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Fig.2B

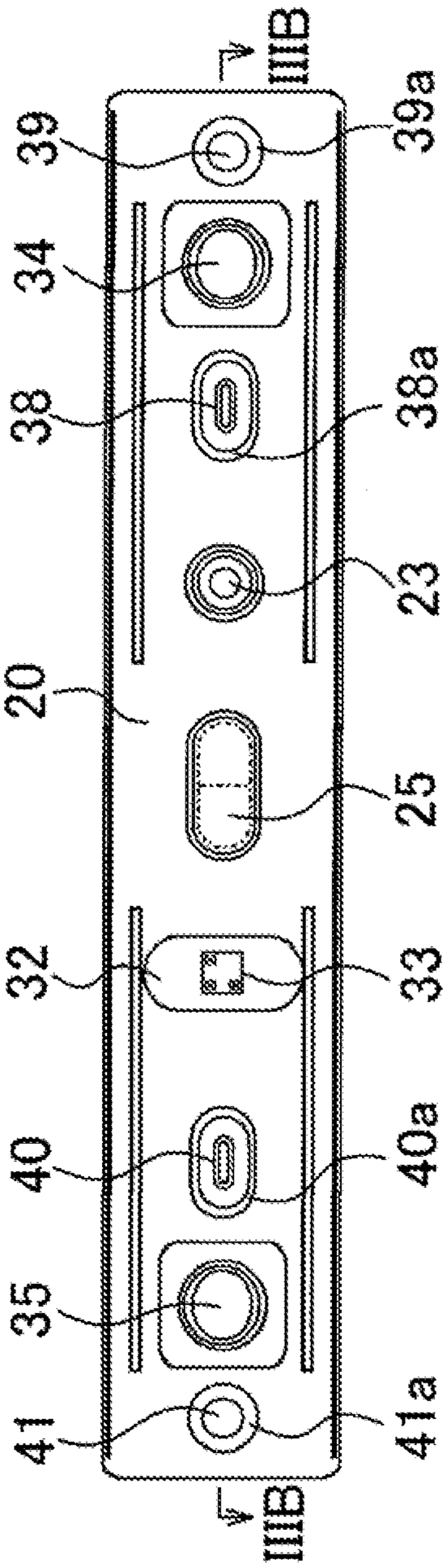

Fig.3A

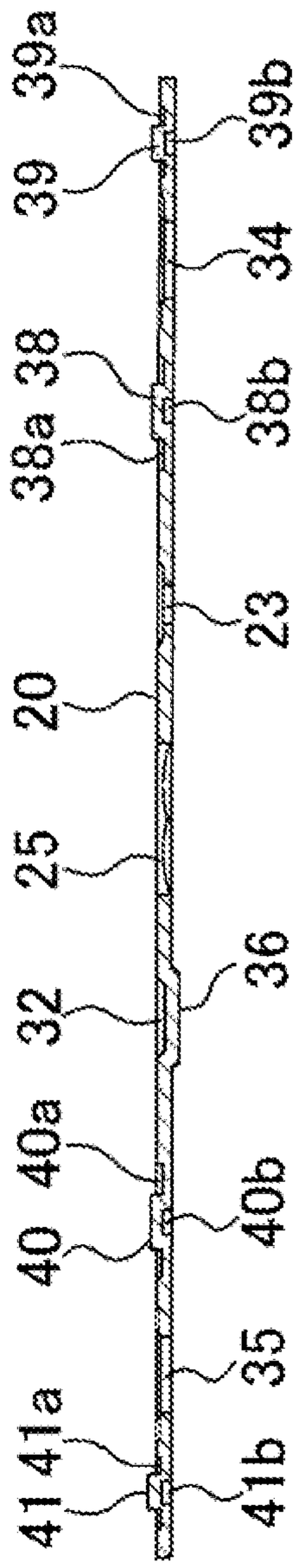

Fig.3B

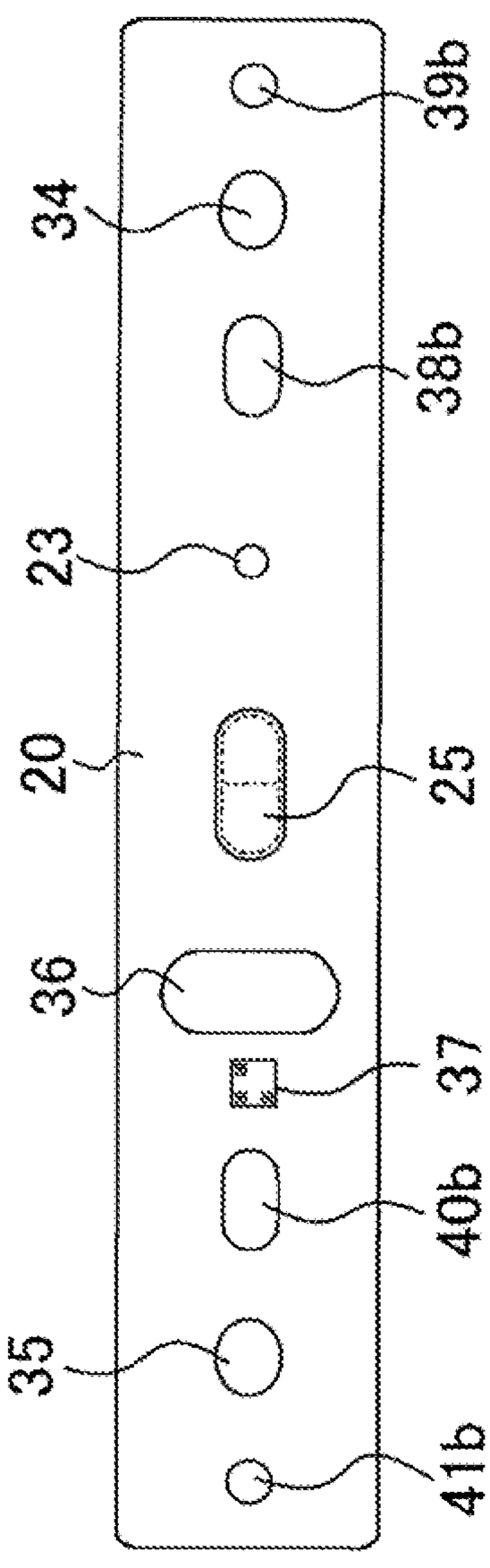

Fig.3C

PRISMATIC SECONDARY BATTERY

TECHNICAL FIELD

The present invention relates to a prismatic secondary battery.

BACKGROUND ART

Alkaline secondary batteries typified by a nickel-hydrogen battery and nonaqueous electrolyte secondary batteries typified by a lithium ion battery are widely used as power supplies for driving portable electronic equipment such as cell phones including smartphones, portable computers, PDAs, and portable music players. In addition, alkaline secondary batteries and the nonaqueous electrolyte secondary batteries are also widely used for power supplies for driving electric vehicles (EVs) and hybrid electric vehicles (HEVs, PHEVs) and in stationary storage battery systems for suppressing the variation in output power of photovoltaic generation, wind power generation, and the like, and for peak shifts in system power in order to store electric power during the night time and to use the electric power during daytime.

In particular, the batteries for EVs, HEVs, and PHEVs and for the stationary storage battery system are required to have high capacity and high output characteristics, and hence each battery is upsized and a number of batteries are connected in series or parallel when used. To address this, in these applications, prismatic secondary batteries are generally used from the viewpoint of space efficiency. A prismatic secondary battery that further needs physical strength commonly employs, as an outer body of the battery, a metal prismatic outer body having a mouth and a metal sealing plate for sealing up the mouth.

Such a prismatic secondary battery, for example, a prismatic nonaqueous electrolyte secondary battery, is produced as follows. For example, both faces of a positive electrode substrate made from, for example, a long sheet of aluminum foil, are coated with a positive electrode active material mixture containing a positive electrode active material to prepare a positive electrode sheet. Separately, both faces of a negative electrode substrate made from, for example, a long sheet of copper foil, are coated with a negative electrode active material mixture containing a negative electrode active material to prepare a negative electrode sheet.

Next, the positive electrode sheet and the negative electrode sheet are stacked interposing a separator made from, for example, a microporous polyethylene film therebetween, and the positive electrode sheet and the negative electrode sheet are spirally wound on a cylindrical winding core while insulating the positive electrode sheet and the negative electrode sheet from each other through the separator to prepare a cylindrical wound electrode assembly. Then, the cylindrical wound electrode assembly is pressed with a pressing machine to form a flat wound electrode assembly. Next, a positive electrode collector electrically connected to the positive electrode sheet is electrically connected to a positive electrode terminal that is insulated from a sealing plate, while a negative electrode collector electrically connected to the negative electrode sheet is electrically connected to a negative electrode terminal that is insulated from a sealing plate. Then, the flat wound electrode assembly is wrapped with a member having insulating characteristics and stored in a metal prismatic outer body; a mouth portion of the prismatic outer body is sealed with a sealing plate; an electrolyte is poured from a electrolyte pour hole provided on the sealing plate; and finally

the electrolyte pour hole is sealed to produce the prismatic nonaqueous electrolyte secondary battery.

Such a prismatic secondary battery required to have high capacity and high output characteristics is required to have much higher safety than that of secondary batteries for portable small equipment. Especially, in the case of a nonaqueous electrolyte secondary battery that uses a material having very high reactivity, for example, as shown in US Patent Publication No. 2010/0233529 (US2010/0233529 (A1)) and U.S. Pat. No. 7,781,088 specification (U.S. Pat. No. 7,781,088 (B2)), this nonaqueous electrolyte secondary battery is equipped with a gas release valve for releasing internal pressure when the pressure in a battery outer body is increased and a current interruption mechanism for interrupting electrical connection between an external terminal and an electrode assembly in the outer body.

The metal sealing plate used for the prismatic secondary battery includes at least a mouth for attaching a positive electrode terminal, a mouth for attaching a negative electrode terminal, gas release valve, and an electrolyte pour hole. The metal sealing plate commonly has a rectangular shape, a chamfered rectangular shape, a rounded rectangular shape, or an oval shape. The mouth for attaching a positive electrode terminal and the mouth for attaching a negative electrode terminal are arranged on both end sides in a longitudinal direction of the sealing plate, and each of the gas release valve and the electrolyte pour hole is provided between the negative electrode terminal and the positive electrode terminal on the sealing plate.

Meanwhile, the prismatic secondary battery is mass-produced and thus is preferred to have a sealing plate with any identification code for providing traceability during an assembly process and after the assembly. Such an identification code can be easily formed by printing, laser marking, or seal-affixing on the sealing plate. However, when an electrolyte is poured from the electrolyte pour hole into the prismatic outer body, there is a possibility that the electrolyte disperses and adheres to the identification code formed on the sealing plate. Adherence of the electrolyte to the identification code deteriorates readability of the identification code. There is also a possibility that the traceability is lost due to corrosion or damage of the identification code by electrolyte adhered to the identification code or by acid generated by a reaction of electrolyte and moisture in the air.

SUMMARY

An advantage of some aspects of the invention is to provide a prismatic secondary battery in which a dispersed electrolyte is unlikely to adhere to an identification code formed on the sealing plate when the electrolyte is poured from an electrolyte pour hole into a prismatic hollow outer body.

According to an aspect of the invention, a prismatic secondary battery comprises: a prismatic hollow outer body having a mouth and a bottom; an electrode assembly including a positive electrode sheet and a negative electrode sheet, a positive electrode collector electrically connected to the positive electrode sheet, a negative electrode collector electrically connected to the negative electrode sheet, and an electrolyte, all being stored in the prismatic hollow outer body; a sealing plate sealing up the mouth of the prismatic hollow outer body; and a positive electrode terminal and a negative electrode terminal attached to the sealing plate in a manner electrically insulated from the sealing plate, while electrically connected to the positive electrode collector and the negative electrode collector, respectively, on the sealing plate, wherein the positive electrode terminal is fixed on one end side in a longitu-

dinal direction of the sealing plate and the negative electrode terminal is fixed on the other end side, the gas release valve and an electrolyte pour hole are formed in the sealing plate between the positive electrode terminal and the negative electrode terminal, the sealing plate includes a front face having an identification code formed on a side opposite to a side having the electrolyte pour hole with respect to the gas release valve in a longitudinal direction of the sealing plate.

In the prismatic secondary battery of the invention, the identification code is formed on the side opposite to the electrolyte pour hole with respect to the gas release valve, and this increases the distance between the electrolyte pour hole and the identification code. As a result, with the prismatic secondary battery of the invention, even when an electrolyte is dispersed at the time when the electrolyte is poured from the electrolyte pour hole into the prismatic hollow outer body, the electrolyte is unlikely to adhere to the identification code, and hence the readability of the identification code is unlikely to deteriorate.

The sealing plate usable in the invention may have, for example, a rectangular shape, a chamfered rectangular shape, a rounded rectangular shape, or an oval shape in a planar view.

The "front face" of the prismatic secondary battery of the invention represents a portion positioned on the outer side of the prismatic secondary battery, while a portion of the sealing plate positioned on the inner side of the prismatic secondary battery is expressed as a "back face". In the prismatic secondary battery of the invention, an applying mode of the identification code may be any known mode, for example, printing, laser marking, and seal-affixing. Among them, laser marking is preferably adopted because the identification code applied is unlikely to be abraded or peeled, and is unlikely to be misread. Examples of the usable types of identification codes include a well-known code including a simple code such as numbers, characters, and symbols, a one-dimensional code such as a bar-code, and a two-dimensional code such as a stacked bar-code. Among them, the two-dimensional code is desirable because it can contain a large amount of information and is misread less frequently even when the code has been abraded or peeled away.

In the prismatic secondary battery of the invention, the gas exhausted valve may be integrally formed with the sealing plate. Alternatively, the gas exhausted valve may be formed by connecting a valve that is separately manufactured from the sealing plate to an opening formed on the sealing plate. In the latter case, the valve may be placed so as to cover the opening formed on the sealing plate, and the peripheral portion of the valve is connected to the sealing plate by laser welding etc.

In the prismatic secondary battery according to the aspect of the invention, the front face of the sealing plate may preferably be provided with a concaved flat face formed on the side opposite to the side having the electrolyte pour hole with respect to the gas release valve in the longitudinal direction of the sealing plate, the concaved flat face has a height less than that of the peripheral portions around the concaved flat face, and the identification code is formed on the concaved flat face.

The concaved flat face is formed on the front face of the sealing plate and has the flat face having a height less than that of the peripheral portions around the sealing plate and includes the identification code formed on the concaved flat face. Hence, even when a jig for assembling the prismatic secondary battery or the like comes into contact with the sealing plate, such a jig is unlikely to come into contact with the identification code part. On this account, with the sealing plate for a prismatic secondary battery of the invention, the identification code is unlikely to be abraded, and therefore the traceability is unlikely to be lost during an assembly process and after the assembly of the prismatic secondary battery. The "concaved flat face" in the sealing plate for a prismatic secondary battery of the invention may include a so-called "groove" including a flat face that has a height less than that of the peripheral portions and that is formed across the whole width (short side direction) of the sealing plate, however, preferably includes a flat face has a height less than that of the peripheral portions thereof which is formed in one part of the width direction (short side direction) of the sealing plate. If the concaved flat face that has a height less than that of the peripheral portions is formed in one part of the width direction of the sealing plate, the reduction in flexural strength with respect to the longitudinal direction of the sealing plate is small in the concaved portion. This can suppress the deformation of the sealing plate when the internal pressure of the prismatic secondary battery is increased and can stabilize working pressure of the gas release valve. Moreover, the sealing plate does not generate a level difference in the fitting portion between the sealing plate and the battery outer body, and this enables uniform laser-welding of the fitting portion between the sealing plate and the battery outer body.

In the prismatic secondary battery according to the aspect of the invention, the sealing plate may preferably include a back face having a convex portion at a position corresponding to the concaved flat face.

The presence of the concaved portion on the front face and the convex portion on the back face of the sealing plate increases the flexural strength of the sealing plate in both the longitudinal direction and the width direction. Hence, such a structure can further suppress the deformation of the sealing plate when the internal pressure of the prismatic secondary battery is increased and can further stabilize working pressure of the gas release valve.

In the prismatic secondary battery according to the aspect of the invention, the gas release valve may preferably be formed at the center between the positive electrode terminal and the negative electrode terminal.

By forming the gas release valve at the center between the positive electrode terminal and the negative electrode terminal, the internal pressure of the battery is evenly applied to the gas release valve, and this stabilizes working pressure of the gas release valve.

In the prismatic secondary battery according to the aspect of the invention, an additional identification code, may be applied on at least one side adjacent to the convex portion in the longitudinal direction of the sealing plate.

In the longitudinal direction of the sealing plate, both sides adjacent to the convex portion are positions at which a jig for assembling the prismatic secondary battery or the like is unlikely to physically come into contact. The back face of the sealing plate is positioned inside of the prismatic secondary battery and is not exposed to the outside after the completion of the prismatic secondary battery. Thus, with the sealing plate for a prismatic secondary battery of the invention, the additional identification code is unlikely to be abraded and hence the traceability is unlikely to be lost, at least during the assembly process of the prismatic secondary battery.

The additional identification code may be the same as or different from the identification code applied onto the concaved flat face. However, the additional identification code is not exposed to the outside after the completion of the prismatic secondary battery and is entirely used to ensure the traceability during an assembly process. Thus, the additional identification code is preferably different from the identification code applied onto the concaved flat face.

In the prismatic secondary battery according to the aspect, it is desirable that the convex portion be provided at a position adjacent to the gas release valve and that the additional identification code be formed at a position opposite to the gas release valve with respect to the convex portion.

The presence of the convex portion at a position adjacent to the gas release valve further increases the flexural strength of the sealing plate in both the longitudinal direction and the width direction. Hence, such a structure can further suppress the deformation of the sealing plate when the internal pressure of the prismatic secondary battery is increased and can further stabilize working pressure of the gas release valve.

In the prismatic secondary battery according to the aspect of the invention, the electrolyte pour hole may preferably be sealed by a sealing plug, the sealing plug is fitted to the electrolyte pour hole so as to pass through the electrolyte pour hole and to protrude beyond both the front face and the back face of the sealing plate. Hence, such a structure can further suppress the deformation of the sealing plate when the internal pressure of the prismatic secondary battery is increased and can further stabilize working pressure of the gas release valve. The sealing plug may preferably be a blind rivet.

In the prismatic secondary battery of the invention, it is optional whether the concaved flat face is on the positive electrode terminal side or on the negative electrode terminal side.

According to an aspect of the invention, a prismatic secondary battery comprises: a prismatic hollow outer body having a mouth and a bottom; an electrode assembly including a positive electrode sheet and a negative electrode sheet, a positive electrode collector electrically connected to the positive electrode sheet, a negative electrode collector electrically connected to the negative electrode sheet, and an electrolyte, all being stored in the prismatic hollow outer body; and a sealing plate sealing up the mouth of the prismatic hollow outer body, the gas release valve and an electrolyte pour hole being formed in the sealing plate, the sealing plate including a front face having an identification code formed on a side opposite to a side having the electrolyte pour hole with respect to the gas release valve in a longitudinal direction of the sealing plate.

In the prismatic secondary battery according to the invention, the front face of the sealing plate may preferably be provided with a concaved flat face formed on the side opposite to the side having the electrolyte pour hole with respect to the gas release valve in the longitudinal direction of the sealing plate, the concaved flat face has a height less than that of the peripheral portions of the concaved flat face, and the identification code is formed on the concaved flat face.

In the prismatic secondary battery according to the invention, the sealing plate may preferably include a back face having a convex portion at a position corresponding to the concaved flat face.

In the prismatic secondary battery according to the invention, an additional identification code may preferably be applied on at least one side adjacent to the convex portion in the longitudinal direction of the sealing plate.

In the prismatic secondary battery according to the invention, the additional identification code may preferably be formed at a position opposite to the gas release valve with respect to the convex portion.

In the prismatic secondary battery according to the invention, the electrolyte pour hole may preferably be sealed by a sealing plug, the sealing plug is fitted to the electrolyte pour hole so as to pass through the electrolyte pour hole and to protrude beyond both the front face and the back face of the sealing plate.

In the prismatic secondary battery according to the invention, the sealing plug may preferably be a blind rivet.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

FIG. **1**A is a front view of a prismatic nonaqueous electrolyte secondary battery of an embodiment and FIG. **1**B is a plan view of the prismatic nonaqueous electrolyte secondary battery.

FIG. **2**A is a partial cross-sectional view taken along the line IIA-IIA in FIG. **1**B and FIG. **2**B is a partial cross-sectional view taken along the line IIB-IIB in FIG. **2**A.

FIG. **3**A is a plan view of a sealing plate of the embodiment, FIG. **3**B is a cross-sectional view taken along the line IIIB-IIIB in FIG. **3**A, and FIG. **3**C is a bottom view of the sealing plate of the embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENT

Hereinafter, embodiment of the invention will be described in detail with reference to the accompanying drawings. However, the embodiment described below is intended to exemplify the technical spirit of the invention, the invention is not intended to be limited to the embodiment, and the invention may equally be applied to various modified cases without departing from the technical spirit described in the claims.

Embodiment

Firstly, as an example of a prismatic secondary battery of the embodiment, a prismatic nonaqueous electrolyte secondary battery will be described with reference to FIG. **1** and FIG. **2**. FIG. **1**A is a front view of the prismatic nonaqueous electrolyte secondary battery, and FIG. **1**B is a plan view of the prismatic nonaqueous electrolyte secondary battery. FIG. **2**A is a cross-sectional view taken along the line IIA-IIA in FIG. **1**B, and FIG. **2**B is a cross-sectional view taken along the line IIB-IIB in FIG. **2**A.

A prismatic nonaqueous electrolyte secondary battery **10** includes a flat wound electrode assembly **11** in which a positive electrode sheet and a negative electrode sheet are wound while being insulated from each other through a separator, which are not shown in the drawings. The positive electrode sheet is prepared by coating both faces of a positive electrode substrate made from aluminum foil with a positive electrode active material mixture, then drying and rolling the coated substrate, and slitting the substrate so as to expose the aluminum foil in a strip shape. Separately, the negative electrode sheet is prepared by coating both faces of a negative electrode substrate made from copper foil with a negative electrode active material mixture, then drying and rolling the coated substrate, and slitting the substrate so as to expose the copper foil in a strip shape.

Then, the flat wound electrode assembly **11** is prepared as follows. The positive electrode sheet and the negative electrode sheet obtained as above are stacked interposing a polyolefin microporous separator therebetween so as to displace the aluminum foil exposed portion of the positive electrode sheet and the copper foil exposed portion of the negative electrode sheet from the corresponding counter electrode active material mixtures, and the whole is wound while insulating the positive electrode sheet and the negative electrode sheet from each other through the separator to afford the flat

wound electrode assembly **11** including one end with a plurality of stacked positive electrode substrate exposed portions **12** and the other end with a plurality of stacked negative electrode substrate exposed portions **13**.

The plurality of stacked positive electrode substrate exposed portions **12** are electrically connected through a positive electrode collector **14** made of aluminum to a positive electrode terminal **15** also made of aluminum, and similarly, the plurality of stacked negative electrode substrate exposed portions **13** are electrically connected through a negative electrode collector **16** made of copper to a negative electrode terminal **17** also made of copper. The positive electrode terminal **15** and the negative electrode terminal **17** are, as shown in FIG. **2**A and FIG. **2**B, fixed to a sealing plate **20** made of, for example, aluminum through an insulating members **18** and **19**, respectively. The positive electrode terminal **15** and the negative electrode terminal **17** are, as necessary, connected to an external positive electrode terminal and an external negative electrode terminal (not shown in the drawings) arranged on the insulating members **18** and **19**, respectively.

The flat wound electrode assembly **11** prepared as above is wrapped with a resin sheet (not shown in the drawings) having insulating characteristics except the sealing plate **20** side and is inserted into a prismatic hollow outer body **21** made of, for example, aluminum having an open face. Then, the sealing plate **20** is fitted to the mouth portion of the prismatic hollow outer body **21**; a fitting portion **22** between the sealing plate **20** and the prismatic hollow outer body **21** is laser-welded; then, a nonaqueous electrolyte is poured from an electrolyte pour hole **23**; and the electrolyte pour hole **23** is sealed up to produce the prismatic nonaqueous electrolyte secondary battery **10** of the embodiment.

A current interruption mechanism **24** that works correspondingly to the pressure of gas generated in the battery is provided between the positive electrode collector **14** and the positive electrode terminal **15**. The sealing plate **20** also equips, at the center between the negative electrode terminal **17** and the positive electrode terminal **15**, a gas release valve **25** that opens when the gas pressure becomes higher than the working pressure of the current interruption mechanism **24**. Thus, the inside of the prismatic nonaqueous electrolyte secondary battery **10** is hermetically sealed. The current interruption mechanism **24** is not necessary to be provided. In the present invention, instead of being provided with the current interruption mechanism **24**, the gas release valve **25** can open when the pressure inside the battery becomes higher than a predetermined value. The prismatic nonaqueous electrolyte secondary battery **10** is used alone or used with a plurality of the batteries connected in series or parallel, for various applications. When a plurality of the prismatic nonaqueous electrolyte secondary batteries **10** are connected in series or parallel to be used, an external positive electrode terminal and an external negative electrode terminal are preferably provided separately for connecting each battery through bus bars so as to send a large current.

In the flat wound electrode assembly **11**, as shown in FIG. **2**A and FIG. **2**B, on the positive electrode sheet side, the plurality of stacked positive electrode substrate exposed portions **12** are divided into two portions, and between the portions, a positive electrode intermediate member **27** made of resin and having a plurality of positive electrode connection conductive members **26**, two positive electrode connection conductive members **26** in the embodiment, is interposed. In a similar manner, on the negative electrode sheet side, the plurality of stacked negative electrode substrate exposed portions **13** are divided into two portions, and between the portions, a negative electrode intermediate member **29** made of resin and having two negative electrode connection conductive members **28** is interposed. On the outermost surface of the positive electrode substrate exposed portions **12** positioned on each side of the positive electrode connection conductive member **26**, a positive electrode collector **14** is disposed, and on the outermost surface of the negative electrode substrate exposed portions **13** positioned on each side of the negative electrode connection conductive member **28**, a negative electrode collector **16** is disposed. The positive electrode connection conductive member **26** is made of aluminum that is the same material as the positive electrode substrate, the negative electrode connection conductive member **28** is made of copper that is the same material as the negative electrode substrate, and the shape of the positive electrode connection conductive member **26** may be the same as or different from that of the negative electrode connection conductive member **28**.

The positive electrode collector **14** is resistance-welded to the positive electrode substrate exposed portion **12** (at four points), and the positive electrode substrate exposed portion **12** is resistance-welded to the positive electrode connection conductive member **26** (at four points), for connection. Similarly, the negative electrode collector **16** is resistance-welded to the negative electrode substrate exposed portion **13** (at four points), and the negative electrode substrate exposed portion **13** is resistance-welded to the negative electrode connection conductive member **28** (at four points), for connection. FIG. **2**A shows, on the positive electrode side, two weld marks **30** formed by the resistance welding and, on the negative electrode side, two weld marks **31**.

Hereinafter, in the flat wound electrode assembly **11** of the Embodiment, the resistance welding method using the positive electrode substrate exposed portions **12**, the positive electrode collector **14**, and the positive electrode intermediate member **27** having the positive electrode connection conductive members **26** and the resistance welding method using the negative electrode substrate exposed portions **13**, the negative electrode collector **16**, and the negative electrode intermediate member **29** having the negative electrode connection conductive members **28** will be described in detail. However, in the Embodiment, the shapes of the positive electrode connection conductive member **26** and the positive electrode intermediate member **27** may be substantially the same as the shapes of the negative electrode connection conductive member **28** and the negative electrode intermediate member **29**, and each resistance welding method may be substantially the same. Therefore, the method for the positive electrode sheet side will be described below as a typical example.

First, the positive electrode substrate exposed portions **12** of the flat wound electrode assembly **11** prepared as above were divided from the wound center to both side into two portions, and the divided positive electrode substrate exposed portions **12** were gathered to a center as a quarter of the thickness of the electrode assembly. Then, the positive electrode collectors **14** were disposed on both sides of the outermost periphery of the positive electrode substrate exposed portions **12**, the positive electrode intermediate member **27** having the positive electrode connection conductive members **26** was inserted between both sides of the bisectional positive electrode substrate exposed portions **12** so that protrusions on both sides of the positive electrode connection conductive member **26** were in contact with the positive electrode substrate exposed portions **12** on the inner periphery thereof. The positive electrode collector **14** is made from, for example, an aluminum plate having a thickness of 0.8 mm.

Here, the positive electrode connection conductive member **26** held with the positive electrode intermediate member **27** in the Embodiment has a column-shaped body with two opposed faces, and a protrusion (projection) having, for example, a truncated cone shape is formed on each face. The positive electrode connection conductive member **26** may have any shape, for example, a prismatic shape and an elliptical column shape, in addition to the cylindrical shape, as long as it is a metal block. Examples of the material usable for forming the positive electrode connection conductive member **26** include copper, a copper alloy, aluminum, an aluminum alloy, tungsten, and molybdenum. In addition to the members made of these metals, for example, a member having a protrusion coated with nickel or a member in which the material of a protrusion and the vicinity of a bottom of the protrusion are changed into a metal capable of accelerating heat generation, such as tungsten and molybdenum and such a protrusion is bonded to the cylindrical-shaped body of the positive electrode connection conductive member **26** made of copper, a copper alloy, aluminum, or an aluminum alloy by brazing or the like may be used.

A plurality of the positive electrode connection conductive members **26** of the Embodiment, for example, two positive electrode connection conductive members are integrally held with the positive electrode intermediate member **27** made of a resin material. In this case, the positive electrode connection conductive members **26** are held so as to be parallel to each other. The positive electrode intermediate member **27** may have any shape, for example, a prismatic shape and a column shape. However, the shape is preferably a prismatic shape having a long lateral length in order to be fixed between the bisectional positive electrode substrate exposed portions **12** while being stably positioned. However, corners of the positive electrode intermediate member **27** are preferably chamfered so as not to scratch or deform the soft positive electrode substrate exposed portion **12** even when the corner comes into contact with the positive electrode substrate exposed portion **12**. At least a part to be inserted between the bisectional positive electrode substrate exposed portions **12** may be chamfered.

The length of the prismatic positive electrode intermediate member **27** varies depending on the size of the prismatic nonaqueous electrolyte secondary battery **10**, but may be 20 mm to several tens of mm. The width of the prismatic positive electrode intermediate member **27** may be substantially the same as the height of the positive electrode connection conductive member **26**, but the prismatic positive electrode intermediate member **27** may have a width of which at least both ends of the positive electrode connection conductive member **26** to be welded are exposed. Both ends of the positive electrode connection conductive member **26** preferably protrude from the surface of the positive electrode intermediate member **27**, but may not necessarily protrude. With such a structure, the positive electrode connection conductive member **26** is held with the positive electrode intermediate member **27** and the positive electrode intermediate member **27** is disposed between the bisectional positive electrode substrate exposed portions **12** while being stably positioned.

Next, between a pair of resistance welding electrode rods (not shown in the drawings), the positive electrode collector **14** and the flat wound electrode assembly **11** with the positive electrode intermediate member **27** holding the positive electrode connection conductive members **26** are disposed. The pair of the resistance welding electrode rods are brought into contact with the positive electrode collectors **14** disposed on both outermost periphery sides of the positive electrode substrate exposed portions **12**. Then, an appropriate pressure is applied between the pair of the resistance welding electrode rods to perform resistance welding in a previously determined constant condition. During the resistance welding, the positive electrode intermediate member **27** is disposed while being stably positioned between the bisectional positive electrode substrate exposed portions **14**. This improves the dimensional precision between the positive electrode connection conductive member **26** and the pair of electrode rods, enables the resistance welding in an exact and stable condition, and can suppress variation in the welding strength.

Next, the specific structure of the sealing plate of the invention will be described with reference to FIG. **3**. FIG. **3**A is a plan view of a sealing plate of the embodiment, FIG. **3**B is a cross-sectional view taken along the line IIIB-IIIB in FIG. **3**A, and FIG. **3**C is a bottom view of the sealing plate of the embodiment.

The sealing plate **20** has, for example, a rectangular shape, includes a mouth **34** for attaching the positive electrode terminal **15** and a mouth **35** for attaching the negative electrode terminal **17** on each end side, and includes an electrolyte pour hole **23**, a gas release valve **25**, and a concave portion **32** between the mouths **34** and **35**. The concave portion **32** has a flat face having a height less than that of the other portions in the sealing plate **20** and being partially formed in a width direction (short side direction) of the sealing plate **20**. When the concave portion **32** is formed across the whole width of the sealing plate **20**, it becomes a so-called "groove." Such a groove largely reduces the flexural strength of the sealing plate **20** in the longitudinal direction as well as generating a level difference between the sealing plate **20** and the end face of the prismatic hollow outer body **21** thereby to interfere with uniform laser-welding. In addition, on the sealing plate **20** of the embodiment, the gas release valve **25** is provided at the center between the mouth **34** for attaching the positive electrode terminal **15** and the mouth **35** for attaching the negative electrode terminal **17**, the electrolyte pour hole **23** is provided on one side of the gas release valve **25**, and the concave portion **32** is provided on the other side.

When a plurality of the prismatic nonaqueous electrolyte secondary batteries are connected in series or parallel, the external positive electrode terminal and the external negative electrode terminal (not shown in the drawings) are respectively attached to the positive electrode terminal **15** and the negative electrode terminal **17**. First insulating member is placed between the external positive electrode terminal and the sealing plate **20** and a second insulating member is placed between the external negative electrode terminal and the sealing plate **20**. The external positive electrode terminal and the first insulating member and the external negative electrode terminal and the second insulating member are respectively fixed. The sealing plate **20** of the embodiment further includes anti-rotation protrusions **38** and **40** and auxiliary protrusions **39** and **41** on both sides of the mouth **34** for the positive electrode and the mouth **35**. The anti-rotation protrusions **38** and **40** and the auxiliary protrusions **39** and **41** are fitted to the first insulating member fixed to the external positive electrode terminal and fitted to second insulating member fixed to the external negative electrode terminal so that the external positive electrode terminal and the external negative electrode terminal are unlikely to rotate.

For the sealing plate **20** of the embodiment, a rectangular aluminum plate is punched out to form the mouths **34** and **35** and the electrolyte pour hole **23** by forging, and the gas release valve **25**, the concaved flat face **32**, the anti-rotation protrusions **38** and **40**, and the auxiliary protrusions **39** and **41** are simultaneously formed. In the sealing plate **20**, concaves **38***a*, **40***a*, **39***a*, and **41***a* are formed on the front face around the

anti-rotation protrusions **38** and **40** and the auxiliary protrusions **39** and **41**. And concaves **38***b*, **40***b*, **39***b*, and **41***b* are formed in the back face of the sealing plate **20** at the place corresponding to the anti-rotation protrusions **38** and **40** and the auxiliary protrusions **39** and **41**. By forming concaves **38***a*, **40***a*, **39***a* and **41***a*, concaves **38***b*, **40***b*, **39***b* and **41***b*, the anti-rotation protrusions **38** and **40** and the auxiliary protrusions **39** and **41** are easy to be formed such that each of them has a height larger than that of the front face of the sealing plate **20**. A convex portion **36** is formed on the back face of the sealing plate **20** corresponding to the concaved flat face **32** formed position.

The formation of the convex portion. **36** on the back face of the sealing plate **20** corresponding to the concave portion **32** formed position as above increases the flexural strength of the sealing plate **20** in both the longitudinal direction and the width direction, compared with the case without the convex portion **36**. Therefore, a prismatic nonaqueous electrolyte secondary battery **10** produced using the sealing plate **20** suppresses the deformation of the sealing plate **20** when the internal pressure is increased, thus the working pressure of the gas release valve **25** is stabilized. Moreover, if the gas release valve **25** is located at the center between the mouth **34** for attaching the positive electrode terminal **15** and the mouth **35** for attaching the negative electrode terminal **17**, the internal pressure is equally applied to the gas release valve **25**, and this can stabilize the working pressure of the gas release valve **25**.

In the sealing plate **20** of the embodiment, a two-dimensional code as a first identification code **33** is formed on the flat face as the bottom of the concaved flat face **32** on the front face by, for example, laser marking, while, a second identification code **37** is similarly formed by laser marking on a surface of a side adjacent to the convex portion **36** on the back face.

The first identification code **33** is formed on the concaved flat face having a height less than that of the peripheral portions that are formed on the front face of the sealing plate **20**. Thus, even when a jig for assembling the prismatic nonaqueous electrolyte secondary battery **10** or the like comes into contact with the sealing plate **20**, such a jig is unlikely to physically come into contact with the first identification code **33**. Therefore, the first identification code **33** is unlikely to be abraded, and the traceability is unlikely to be lost during the assembly process and after the assembly of the prismatic nonaqueous electrolyte secondary battery **10**. The second identification code **37** is not exposed to the outside after the assembly of the prismatic nonaqueous electrolyte secondary battery **10**, but is used for tracing during an assembly process of the prismatic nonaqueous electrolyte secondary battery **10**. The first identification code **33** may be the same as or different from the second identification code **37**.

Here, the laser marking is exemplified for explaining the application of the first identification code **33** and the second identification code **37**, but well-known printing or seal-affixing may be adopted. However, the laser marking is preferably adopted because an applied code is unlikely to be abraded or peeled and is unlikely to be misread. Examples of the usable type of the identification code includes, in addition to the QR code, a simple code such as numbers, characters, and symbols, a one-dimensional code such as a bar-code, and a two-dimensional code such as a stacked bar-code. Among them, the QR code is desirable because it can contain a large amount of information and is misread less frequently even when the code has been abraded or peeled away. In addition, the first identification code **33** is formed on the side opposite to the electrolyte pour hole **23** through the gas release valve **25**, and this increases the distance between the electrolyte pour hole **23** and the first identification code **33**. As a result, even when an electrolyte is dispersed at the time when the electrolyte is poured from the electrolyte pour hole **23** into the prismatic hollow outer body **21**, the electrolyte is unlikely to adhere to the first identification code **33**, and hence the readability of the identification code is unlikely to be deteriorated by the electrolyte.

As the sealing plate **20** of the embodiment, the exemplified sealing plate has the convex portion **36** on the back face corresponding to the concaved flat face **32** that is formed on the front face, but the convex portion **36** is not a necessary component. For example, when the concaved flat face **32** is formed on the front face by cutting work, the convex portion is not formed. However, a sealing plate without such a convex portion does not have the advantage of abrasion resistance or peel resistance with respect to the identification code formed on the back face as well as having a smaller flexural strength in the longitudinal direction of the sealing plate **20**. To address this, the convex portion **36** is preferably formed on the back face corresponding to the concaved flat face **32** that is formed on the front face as in the case of the sealing plate of the embodiment.

The embodiment describes the prismatic nonaqueous electrolyte secondary battery as an example of the prismatic secondary battery. However, the invention is also applicable to a prismatic secondary battery using an aqueous electrolyte, such as a nickel-hydrogen secondary battery.

The embodiment describes the prismatic nonaqueous electrolyte secondary battery as an example in which the positive electrode terminal and the negative electrode terminal are attached to the sealing plate in a manner electrically insulated from the sealing plate. Besides, the negative electrode terminal can be attached to the sealing plate in a manner electrically insulated and the positive electrode collector can be electrically connected to the prismatic hollow outer body or the sealing plate, thus the prismatic hollow outer body and the sealing plate can have a positive potential, for example. Alternatively, the prismatic hollow outer body and the sealing plate can have a negative potential.

What is claimed is:

1. A plurality of prismatic secondary batteries connected in series or parallel comprising:

a prismatic hollow outer body having a mouth and a bottom;

an electrode assembly including a positive electrode sheet and a negative electrode sheet, a positive electrode collector electrically connected to the positive electrode sheet, a negative electrode collector electrically connected to the negative electrode sheet, and an electrolyte, all being stored in the prismatic hollow outer body;

a sealing plate sealing up the mouth of the prismatic hollow outer body; and

a positive electrode terminal and a negative electrode terminal attached to the sealing plate in a manner electrically insulated from the sealing plate, while electrically connected to the positive electrode collector and the negative electrode collector, respectively,

on the sealing plate, the positive electrode terminal being fixed on one end side in a longitudinal direction of the sealing plate and the negative electrode terminal being fixed on the other end side,

the gas release valve and an electrolyte pour hole being formed in the sealing plate between the positive electrode terminal and the negative electrode terminal,

the sealing plate including a front face having an identification code formed on a side opposite to a side having

the electrolyte pour hole with respect to the gas release valve in a longitudinal direction of the sealing plate;

wherein each of said plurality of prismatic secondary batteries has a unique identification code, and

wherein the front face of the sealing plate is provided with a concaved flat face formed on the side opposite to the side having the electrolyte pour hole with respect to the gas release valve in the longitudinal direction of the sealing plate, the concaved flat face has a height less than that of the peripheral portions of the concaved flat face, and the identification code is formed on the concaved flat face.

2. The plurality of prismatic secondary batteries according to claim **1**, wherein the sealing plate includes a back face having a convex portion at a position corresponding to the concaved flat face.

3. The plurality of prismatic secondary batteries according to claim **2**, wherein an additional identification code is applied on at least one side adjacent to the convex portion in the longitudinal direction of the sealing plate.

4. The plurality of prismatic secondary batteries according to claim **3**, wherein the additional identification code is formed at a position opposite to the gas release valve with respect to the convex portion.

5. The plurality of prismatic secondary batteries according to claim **1**, wherein the gas release valve is formed at the center between the positive electrode terminal and the negative electrode terminal.

6. The plurality of prismatic secondary batteries according to claim **1**, wherein the electrolyte pour hole is sealed by a sealing plug, the sealing plug is fitted to the electrolyte pour hole so as to pass through the electrolyte pour hole and to protrude beyond both the front face and the back face of the sealing plate.

7. The plurality of prismatic secondary batteries according to claim **6**, wherein the sealing plug is a blind rivet.

8. A prismatic secondary battery comprising:

a prismatic hollow outer body having a mouth and a bottom;

an electrode assembly including a positive electrode sheet and a negative electrode sheet, a positive electrode collector electrically connected to the positive electrode sheet, a negative electrode collector electrically connected to the negative electrode sheet, and an electrolyte, all being stored in the prismatic hollow outer body; and

a sealing plate sealing up the mouth of the prismatic hollow outer body,

a gas release valve and an electrolyte pour hole being formed in the sealing plate,

the sealing plate including a front face having an identification code formed on a side opposite to a side having the electrolyte pour hole with respect to the gas release valve in a longitudinal direction of the sealing plate,

wherein the front face of the sealing plate is provided with a concaved flat face formed on the side opposite to the side having the electrolyte pour hole with respect to the gas release valve in the longitudinal direction of the sealing plate, the concaved flat face has a height less than that of the peripheral portions of the concaved flat face, and the identification code is formed on the concaved flat face.

9. The plurality of prismatic secondary batteries according to claim **8**, wherein the sealing plate includes a back face having a convex portion at a position corresponding to the concaved flat face.

10. The plurality of prismatic secondary batteries according to claim **9**, wherein an additional identification code is applied on at least one side adjacent to the convex portion in the longitudinal direction of the sealing plate.

11. The plurality of prismatic secondary batteries according to claim **10**, wherein the additional identification code is formed at a position opposite to the gas release valve with respect to the convex portion.

12. The plurality of prismatic secondary batteries according to claim **8**, wherein said plurality of prismatic secondary batteries are connected in series or parallel.

13. The plurality of prismatic secondary batteries according to claim **12**, wherein

in each of the plurality of prismatic secondary batteries, the front face of the sealing plate is provided with a concaved flat face formed on the side opposite to the side having the electrolyte pour hole with respect to the gas release valve in the longitudinal direction of the sealing plate, and

the concaved flat face has a height less than that of the peripheral portions of the concaved flat face, and the identification code is formed on the concaved flat face.

14. A prismatic secondary battery comprising:

a prismatic hollow outer body having a mouth and a bottom;

an electrode assembly including a positive electrode sheet and a negative electrode sheet, a positive electrode collector electrically connected to the positive electrode sheet, a negative electrode collector electrically connected to the negative electrode sheet, and an electrolyte, all being stored in the prismatic hollow outer body; and

a sealing plate sealing up the mouth of the prismatic hollow outer body,

a gas release valve and an electrolyte pour hole being formed in the sealing plate,

the sealing plate including a front face having an identification code formed on a side opposite to a side having the electrolyte pour hole with respect to the gas release valve in a longitudinal direction of the sealing plate;

wherein the identification code is unique from other identification codes of other prismatic secondary batteries,

wherein the front face of the sealing plate is provided with a concaved flat face formed on the side opposite to the side having the electrolyte pour hole with respect to the gas release valve in the longitudinal direction of the sealing plate, and

wherein the concaved flat face has a height less than that of the peripheral portions of the concaved flat face, and the identification code is formed on the concaved flat face.

15. The prismatic secondary battery according to claim **14**, wherein the sealing plate includes a back face having a convex portion at a position corresponding to the concaved flat face.

16. The prismatic secondary battery according to claim **15**,

wherein an additional identification code is applied on at least one side adjacent to the convex portion in the longitudinal direction of the sealing plate.

17. The prismatic secondary battery according to claim **16**,

wherein the additional identification code is formed at a position opposite to the gas release valve with respect to the convex portion.

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